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# PATENT SPECIFICATION

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## (54) IMPROVEMENTS IN CALCINING CALCIUM SULPHATE DIHYDRATE

(71) We, BPB INDUSTRIES LIMITED, a British Company, of Ferguson House, 15/17 Marylebone Road, London, NW1 5JE, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method and apparatus for calcining calcium sulphate dihydrate, and more especially to the production of calcined plaster from gypsum employing a calcining kettle.

Gypsum calcination can be carried out as a batch or continuous operation. In our view, the production rate in both batch and continuous kettle calcinations is at present limited by the maximum permissible heat transfer through the kettle bottom. The quantity of heat which can be transferred through the kettle bottom is limited because there is a maximum allowed temperature of the bottom metal, steel, of the kettle. Above this limit there is a danger of frequent kettle bottom burn-outs. The present invention aims to increase the heat input to the calcining kettles in both batch and continuous operations, thereby increasing the production capacity of the kettle, without risk of adversely affecting the product quality, or of significantly increasing kettle bottom temperatures.

According to the present invention there is provided a method of calcining calcium sulphate dihydrate in which the dihydrate is heated in a calcination vessel by heat applied indirectly through the external walls of the vessel and additionally by the direct introduction of non-reactive, hot gas, preferably hot gaseous combustion products, into the interior of the mass of dihydrate within the vessel through a tube extending generally downwardly from the top of the vessel and provided with at least one opening in its lower region which is immersed in the mass of material. The hot gas should not of course react with the

vessel contents and the term "non-reactive" is used in this sense.

The invention also provides apparatus for calcining calcium sulphate dihydrate comprising an externally heated gypsum calcination kettle and a tube extending generally downwardly into the interior of the kettle from the top thereof, the upper region of the tube being in communication with a non-reactive hot gas source and the lower region of the tube having at least one opening for the escape of hot gas into the contents of the kettle.

In the preferred form of the invention, use is made of a fuel burner located at the top of the calcination vessel or tube. The combustion gases are preferably distributed through distribution holes in the side wall of the lower region of the tube within the bed. The burner may be conveniently located on top of the gypsum calcining kettle, with the tube leading into the bed. The lower region of the tube should preferably be open-ended. An auxiliary air inlet should preferably be provided in the tube between the burner and the lower region of the tube, notably prior to the entry of the tube into the material in the vessel, whereby air can be introduced to control the temperature of the mixture of air and hot combustion gases in the tube as required, for the production of hemihydrate plasters, anhydrous plasters and/or mixtures including projection plaster.

For the insertion of the tube inside the existing conventional calcination kettles, modifications may have to be made to some of the existing stirrer blades to allow location of the tube within the kettle. It may be possible to use a hollow stirrer shaft as the hot gas tube, or the hot gas tube may surround the shaft. These modifications will not, in general, adversely affect the performance of the kettle, or the characteristics of the plaster product.

The present invention will now be more fully described by way of example only, with reference to the drawings

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accompanying the provisional specification, in which:

Figure 1 illustrates schematically the control system for the heat-supplying tube used in the invention,

Figure 2 shows partly in section the heat-supplying tube, and

Figures 3 and 4 show side elevations of two types of continuous calcination kettle provided with heat-supplying tubes.

Referring to Figures 1 and 2, a mixture of air and fuel gas, for example natural gas, is supplied through a pipe 1 to a gas burner 2. The fuel-air mixture is ignited by a spark probe 3 and the hot, gaseous products of combustion pass downwardly through a tube 4 within which the burner 2 is enclosed. The tube 4 in its preferred form is open-ended at its lower end and is provided with holes 5 for distributing the hot gases to material in which the tube is immersed. Auxiliary air is supplied through an inlet 6 in the side of the tube 4 for controlling the temperature of the hot gases passing through the tube 4.

The fuel gas is supplied along a line 7 provided with a non-return valve 8, a governor 9 and a meter 11, to an injector 12 where it mixes with combustion air supplied along a line 13. The fuel-air mixture is then blown by a booster fan 14 to the burner 2 along the line 1. Control valves 16 and 17 are provided in the fuel and air lines 7 and 13, respectively, for controlling the flow rates, whereby the heat generated by the burner can be controlled and the optimum fuel to air ratio can be selected.

An electrical control unit 18 is provided, which supplies the electrical impulse for the ignition spark along a lead 19 to the spark probe 3. As a safety precaution a flame-sensing probe 21 is positioned within the heat-supplying tube 4 and is arranged to be impinged upon by the flame from the burner 2. The probe 21 is connected by a lead 22 to the control unit 18. In the event of flame failure, the control unit 18 automatically closes a solenoid-operated valve 23 in the fuel supply line 7, the valve 23 being connected to the control unit 18 by a lead 24.

The auxiliary air for the heat-supplying tube 4 is blown to the auxiliary air inlet from a fan 20 along a line 25, and the supply of the auxiliary air can be controlled by a valve 30 in the line 25.

Referring to Figures 3 and 4, there are shown heat-supplying tubes 4, each similar to that shown in Figure 2, fitted into continuous calcination kettles of capacity of 3 cwt. and 1 ton, respectively. The same reference numerals will be used to refer to parts which are similar in each Figure.

The continuous calcination kettle, which is in the form of an open-topped vessel 26

having a lid 27 is positioned within a combustion chamber 28. A gas burner is mounted in the combustion chamber 28 beneath the closed bottom of the vessel 26, and heats a mass of gypsum contained in the vessel by conduction through the bottom and side walls of the vessel.

In each of the kettles shown, a heat-supplying tube 4 is mounted in the lid 27 of the kettle, and heats the gypsum directly by introducing hot combustion gases into the interior of the mass of gypsum through the distribution holes 5 and the open end of the tube 4.

Whilst the above system employs fuel gas, other fuels may be used.

In the continuous calcination process, raw gypsum is fed into the kettle continuously through an inlet 29 in the lid 27 and displaces the calcined product which leaves through a product overflow tube 31 leading from an opening in the side wall of the vessel 26. In Figure 4, a baffle plate 32 is mounted within the calcination vessel 26. In order to prevent freshly introduced raw gypsum from leaving through the overflow tube 31 before it has been sufficiently calcined, the plate 32 extends into the mass of gypsum below the level of the opening in the side of the vessel to which the overflow tube 31 is connected, and extends into contact with the inner surface of the vessel on either side of the said opening. In large-scale production it is preferred to employ a product outflow tube which extends upwardly from the lower end of the vessel 26. A downwardly and outwardly inclined discharge conduit communicates with this tube at a point below the level of the lid 27 of the vessel. The product flows up the outflow tube and then overflows down the discharge conduit to a hot pit storage area.

The kettles are each provided with a vent 33 which leads to a cyclone or other dust collection equipment, and have an outlet 34 at the bottom of the vessel through which the contents of the kettle can be dumped when desired. The kettle shown in Figure 3 has an inlet conduit 36 for returning to the interior of the mass of gypsum solids which have been separated at the cyclone. Each kettle has stirrer paddles 37 mounted on a rotating shaft 38 below the end of the tube 4, for stirring the mass of material in the vessel 26 during the calcination process. Instead of employing the tube 4, the shaft 38 could be made hollow and be provided with holes along its length. Alternatively, the shaft 38 could be surrounded by a concentrically arranged combustion tube such as the tube 4. The modified shaft could then be used to introduce hot gaseous products of combustion into the mass of gypsum.

In the following Example, a continuous

operation was carried out employing the kettle shown in Figure 3 with and without auxiliary heating from the tube 4, and employing natural gas as the fuel for the tube 4 and the bottom burner mounted under the vessel. The production rate with only the conventional kettle bottom burner in operation was 42 kg/hr at a natural gas flow rate through the kettle bottom burner of approximately 4.2 m<sup>3</sup>/hr. When an equal proportion of additional heat was

introduced through the heat-supplying tube 4, the production rate could be increased substantially without considerably affecting the kettle bottom temperature or the chemical composition of the product (hemihydrate plaster), although the plaster is more dispersive. The chemical analyses and kettle bottom temperatures of the product with and without the use of submerged combustion are illustrated in the following Table:

	With only the conventional kettle bottom burner	Kettle bottom burner plus heat-supplying tube 4
Gypsum mineral feed (kg/hr)	50	110
Product discharge (kg/hr)	42	74
Calcination temperature (°C)	153	170
Natural gas flow rate to kettle bottom burner (m <sup>3</sup> /hr)	4.19	4.25
Natural gas flow rate to burner 2 (m <sup>3</sup> /hr)	—	4.25
Kettle bottom temperature (°C)	269	266
Approximate Analysis:		
Free water %	0.57	—
Soluble anhydrite %	—	5.9
Hemihydrate %	68	69.7
Gypsum %	8.36	0.98

While a continuous calcination process has been described in detail above, it is apparent that the heat-supplying tube could be used as an auxiliary heating source in batch calcination of calcium sulphate dihydrate.

#### WHAT WE CLAIM IS:—

1. A method of calcining calcium sulphate dihydrate in which the dihydrate is heated in a calcination vessel by heat applied indirectly through the external walls of the vessel and additionally by the direct introduction of non-reactive hot gas into the interior of the mass of calcining material within the vessel through a tube extending generally downwardly from the top of the vessel and provided with at least one opening in its lower region, which is immersed in the mass of material.

2. A method according to Claim 1 wherein the hot gas is distributed through distribution holes in the side walls of the lower region of the tube.

3. A method according to Claim 1 or 2 wherein the lower region of the tube is open-ended.

4. A method according to Claim 1, 2 or 3 wherein the hot gas comprises hot gaseous combustion products.

5. A method according to Claim 4 wherein the combustion products are supplied by a fuel burner located at the top of the calcination vessel or tube.

6. A method according to Claim 4 or 5 wherein an additional flow of air is introduced into the tube between the burner and the entry of the tube into the mass of calcining material in the vessel.

7. A continuous method according to any

preceding claim wherein the calcium sulphate dihydrate is fed continuously into the vessel and displaces the calcined product through an overflow outlet.

- 5 8. Apparatus for calcining calcium sulphate dihydrate comprising an externally heated gypsum calcination kettle and a tube extending generally downwardly into the interior of the kettle from the top thereof,  
10 the upper region of the tube being in communication with a source of non-reactive hot gas and the lower region of the tube having at least one opening for the escape of hot gas into the contents of the  
15 kettle.

9. Apparatus according to Claim 8 wherein the side wall of the tube in its lower region is provided with distribution holes for distributing hot gas into the interior of  
20 the kettle.

10. Apparatus according to Claim 8 or 9 wherein the tube is open at its lower end.

11. Apparatus according to any of Claims 8 to 10 including a fuel burner located on  
25 top of the kettle or tube for supplying hot gaseous combustion products to the tube.

12. Apparatus according to Claim 11 wherein the tube is provided with an auxiliary air inlet between the burner and  
30 the lower region of the tube.

13. Apparatus according to any of Claims 8 to 12 wherein the tube is the hollow shaft of a stirrer for the kettle or surrounds the

shaft of a stirrer for the kettle.

14. Apparatus according to any of Claims 8 to 13 wherein the kettle is provided with an inlet for raw calcium sulphate dihydrate and an overflow outlet through which, in operation, the calcined product is continuously discharged.

15. Apparatus according to Claim 14 wherein the kettle is provided with a baffle plate which extends into the vessel to below the level of the discharge outlet.

16. A method of calcining calcium sulphate dihydrate substantially as hereinbefore described with reference to the drawings accompanying the provisional specification.

17. A method of calcining calcium sulphate dihydrate substantially as hereinbefore described in the Example.

18. Calcined calcium sulphate dihydrate obtained by a method according to any one of Claims 1 to 7, 16 or 17.

19. Apparatus for calcining calcium sulphate dihydrate substantially as hereinbefore described with reference to and as shown in the drawings accompanying the provisional specification.

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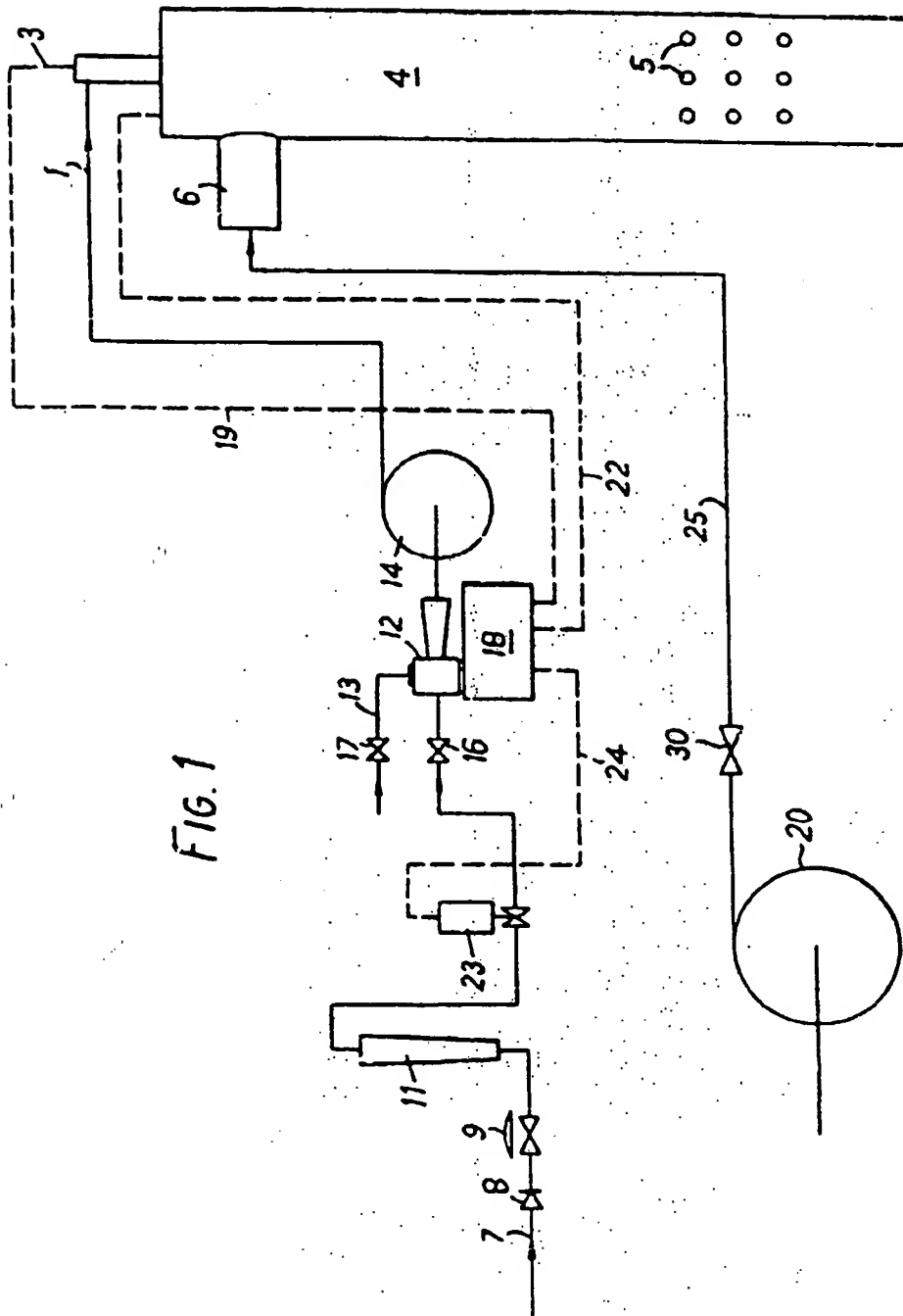


FIG. 3

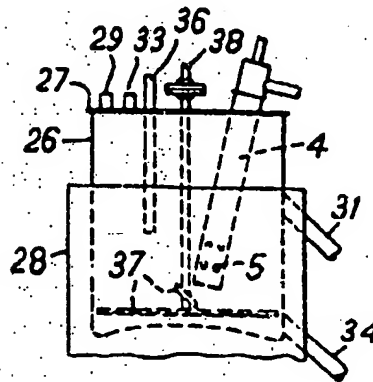


FIG. 2

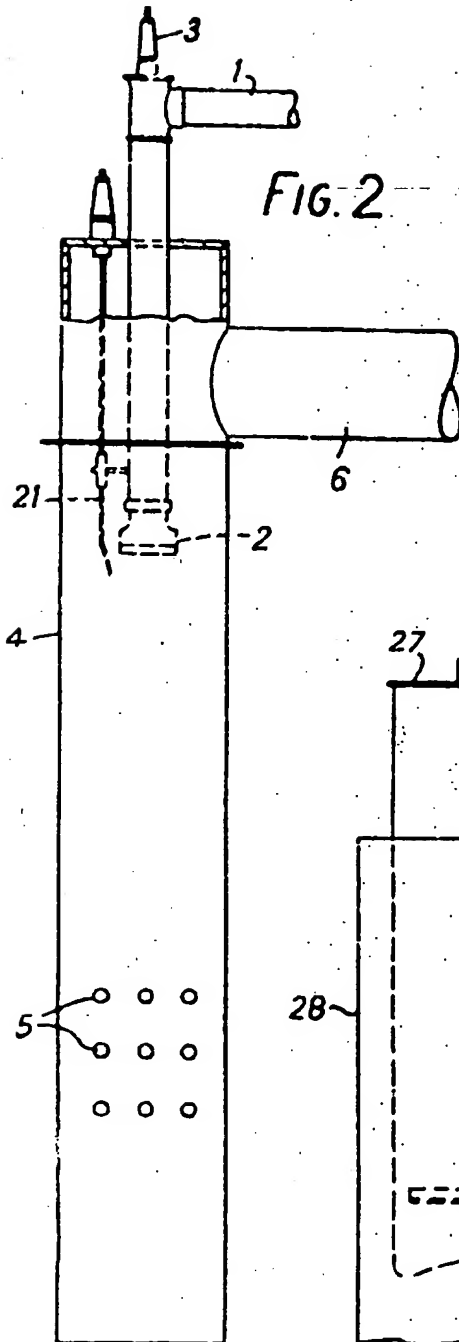


FIG. 4

